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UNPUBLISHED PRELIMINARY DATA

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Dr. T. L. K. Smull, Director
Office of Research Grants and Contracts
National Aeronautics and Space Administration
Code SC
Washington 25, D. C.

Dear Dr. Smull:

This letter constitutes the semi-annual status report on the research work supported by NASA under Research Grant NsG 260-62 to the University of Arkansas entitled "Techniques of Radio Frequency Mass Spectrometry", through October 1, 1964.

ION ATTITUDE STUDY

The ion attitude study consists of two regions of investigation. First, the effect on the mass spectrum of ions created at energies corresponding to the apparent velocities of ions entering an orbiting ion spectrometer is of interest. Secondly, it is necessary to know the effect on the mass spectrum of ions entering an orbiting ion spectrometer at various angles or attitudes. These two studies necessitate a large, highly uniform, nearly parallel beam of ions whose energy of formation can readily be changed. In addition this beam must impinge upon the guard ring of the ion spectrometer at known incident angles. The ion beam must be significantly larger than the mouth of the ion spectrometer and the density must be high enough that the spectrometer's detection ability is not limited as the entrance angle of the ion approaches 90 degrees.

The vacuum chamber, which also serves as the means of ion attitude variation, has been completed. This chamber has functioned properly since the initial pumpdown. The dual Teflon o-ring seal with differential pumping permits maximum ease of rotation of the ion gun with practically no change in pressure. With an activated zeolite trap the ultimate pressure in the attitude chamber approaches 2.0×10^{-7} Torr. During rotation of the chamber the pressure is maintained at $(2.05 \pm 0.05) \times 10^{-7}$ Torr.

The ion generation region must produce an acceptably uniform ion beam from the electron source. The design of the electron source evolved into a spiral rhenium filament which has been flattened in a plane perpendicular to the system axis to insure mechanical rigidity and to produce increased electrons with less power. This electron source is sufficiently large that, by operating in the space charged limited condition, the ionizing electron beam is quite uniform and rather dense.

The cross-sectional density of the ion beam so generated from the above electron beam is more uniform than the electron beam due to the mixing effect of the ionization region. A three element thick electrostatic lens follows the ionization region. This lens collimates the ions so that the cross-sectional density of the ion beam is relatively constant in the region of entrance to the spectrometer.

The entire ion generation and collimation regions are under final checkout prior to assemblage of the entire system in the test chamber. The ion spectrometer checkout has been completed. Data will be taken for ions entering the ion spectrometer at angles varying from 0 to 90 degrees with the entrance energy of the ions varying from 0 to 30 ev.

ION FOCUSING STUDY

The two pulling out grids and the first D.C. or scan grid of the RF mass spectrometer determine the path of a charged particle in a manner similar to that of a three element electrostatic thin lens. Since the effective aperture diameter is much greater than the grid separation, the focusing fields are weaker than with standard thin lenses.

A study of the effect upon the ion current passage of different lens configurations within the thin lens domain has been carried out. The initial studies were performed independent of an ion spectrometer. The lens system consisting of three standard mesh grids spaced one-eighth inch apart produced the largest increase in total ion current and maintained the most uniform beam. Low-mass discrimination appears to be slightly less for this lens configuration as well. The optimum pulling out grid voltage combination is: -50 volts on the 1st pulling out grid; -120 volts on the 2nd pulling out grid. The ion current delivered by this voltage combination is about twice that delivered by the -10, -120 volt configuration.

The following studies are being performed on the ion spectrometer:

1. Effect of lens configuration on total sensitivity and efficiency.
2. Effect of lens configuration on spectrometer resolution.
3. Effect of lens configuration on peak position (on scan potential axis).
4. Effect of lens configuration on mass discrimination.

COLD ELECTRON MASS SPECTROMETRIC ION SOURCE

The resistance strip electron multiplier, activated by electrons from a photocathode, has been used as an electron source for an ionization gauge and a Bennett type RF mass spectrometer.

Spectra for air, using this cold source, were similar to those obtained with a thermionic emitter. However, with the cold source there was little or no gettering of the air sample by the source; no serious outgassing effects; no contribution to the mass 28 peak caused by carbon monoxide produced at the source; no thermal fragmentation of the sample molecules; no temperature variations in the source region; and no deposits due to evaporated metal, metal oxides, or reaction products.

Initially, electrons exiting from the multiplier were deflected by the magnetic field of the multiplier and did not enter the ionization region. A deflection plate was installed at the exit end of the multiplier, correcting this situation. Present studies involve using an offset ionization region, eliminating the use of the deflection plate.

The initial gain of the multiplier decreased exponentially reaching a plateau in a few hours. The output current at this plateau was still sufficient for ionization purposes. Feasible emission regulation techniques include variation of the dynode potential, variation of ultraviolet radiation input to the photocathode, and variation of potential on a grid between photocathode and the multiplier input. The multiplier lifetime was determined to be related to the atmosphere in which it was operated. Hence, the lifetime is appreciably increased when an oil free system is used. Future investigations will include optimization of the ionization region, improvement of emission current regulation, and production of a prototype multiplier as a mass spectrometer ion source.

ION GATHERING STUDY

The thorough study of the large diameter lens associated with the focusing studies as well as studies of lens systems on previous NASA grants has presented a basis for the collection of ions from a much larger area than is possible in present ion spectrometers. The technique, which might also be called funneling, promises the ability to sample larger numbers of ambient ions without greatly increasing the dimensions of the present spectrometers.

The hardware has been completed for this study with the exception of insulators which are not available from the regular source. A new source has recently been found and the insulators are in the process of being constructed. This new source did not produce an insulator of sufficient mechanical strength to be machined. Therefore, other sources are being studied.

Sincerely yours,

M K Testerman

M. K. Testerman
Principal Investigator